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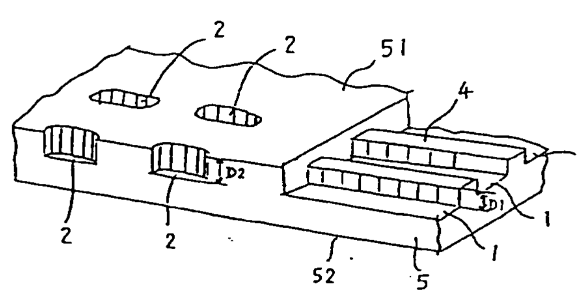
(54) An optical disk for use in optical memory devices.

(57) An optical disk (5) for use in optical memory devices comprises guide grooves (1) and pits (2) on one surface (51) thereof, wherein the depth of the guide grooves (1) is different from that of the pits (2). The distance from the bottom face of each of the guide grooves (1) to the other surface (52) of the optical disk opposite to the one surface (51) of the optical disk (5) on which the guide grooves (1) and pits (2) are disposed is the same as the distance from the bottom face of each of the pits (2) to the other surface (52) of the optical disk opposite to the one surface (51) of the optical disk (5) on which the guide grooves and pits are disposed. Also disclosed is a method for the production of optical memory master plates (88) that are used for the production of the above-mentioned optical disk (5).

Fig. 1



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Description

AN OPTICAL DISK FOR USE IN OPTICAL MEMORY DEVICES

The present invention relates to an optical disk for use in optical memory devices that conduct a recording operation, a regenerating operation, or an erasing operation of information by means of laser beams, and to a method for the production of the optical disk.

In recent years, optical memory devices have come to public notice as a dense and mass memory device. They can be classified into three groups consisting of regenerative memory devices, write once memory devices and rewritable memory devices. Optical memory devices, which can be classified into write once memory devices and rewritable memory devices, generally have guide tracks on a disk made of glass or plastics so as to guide a light beam for recording and/or regenerating information to a given portion of the optical memory device. A portion of each of the guide tracks is formed into a pit-shape, resulting in a track address by which the position of the guide track can be identified. When the sectionalization of each guide track is needed to administer information, sector addresses are also diposed in the disk.

Figure 10 shows a conventional disk 500 with guide tracks that are constituted by grooves 100. Information such as track addresses, sector addresses or the like that are disposed on the disk 500 in advance is formed into the shape of pits 200. In general, on the disk with guide grooves and pits, a recording medium is formed by the vacuum evaporation method, the sputtering method, the spin-coating method or the like. When necessary, a protective substrate and/or a resin film is laminated on the recording medium, resulting in an optical memory device.

Because information is recorded on the guide tracks 100 (Figure 10) by means of light such as laser beams or the like, the shape of the grooves 100 significantly influences the tracking servo signal characteristics that are essential to keep a light beam spot on a given guide track. To obtain good tracking servo signal characteristics, the depth of guide grooves that are formed in the disk are usually set to be around $\lambda/8$ n (wherein λ is a wavelength of light and n is the refractive index of the disk). On the other hand, because information such as track addresses, sector addresses or the like that are formed into a pit-shape on the disk is read off by utilizing a diffraction effect of light in the pits the depth of each pit is set to be around $\lambda/4$ n. In this way, the depth of guide grooves 100 of a disk 500 for use in optical memory devices is different from the depth of the pits 200 of the said disk. This kind of disk 500 is designed such that, as shown in Figure 10, one surface 300 of the disk 500 is flush with the surface of the land 400 positioned between the adjacent guide grooves 100 that are formed on the said surface 300 of the disk 500.

Figures 11a to 11d show a production process of the above-mentioned disk 500. As shown in Figur 11a, a resist film 600 that has been formed on a disk plate 10 is illuminated with a laser beam 700, resulting in guide groove and pit latent images on the resist film 600. The intensity of illumination of the laser beam 700 for the formation of guide groove latent images is set to be lower than that of illumination of the laser beam for the formation of pit latent images. Then, the resist film 600 is developed, as shown in Figure 11b, resulting in a pattern 660 that corresponds to the guide grooves 100 and pits 200 shown in Figure 10, the depths of which are different from each other. The disk plate 10 with a pattern 660 is then subjected to a dry or wet etching treatment, resulting in a disk 500 such as that of Figure 10. Alternatively, as shown in Figure 11c, a metal film 800 made of nickel (Ni) or the like is formed on the disk plate 10 with a pattern 660 by the sputtering method, the vacuum evaporation method and/or the electroforming method, resulting in a stamper (i.e., a master plate) 880 as shown in Figure 11d. By the use of the stamper 880, a plastic disk with a structure such as that shown in Figure 10 can be formed by an injection technique.

Because the shape of the bottom of each of the grooves 100 formed on a disk 500 is a transcription of the shape of the top surface of the patterned photoresist film 660, the bottom face of each of the grooves of the disk 500 is formed into an unevenness that corresponds to the unevenness of the top surface of the patterned resist film 660, which causes noise when information that has been written into the guide grooves (i.e., guide tracks) 100 of the disk 500 by means of a laser beam is regenerated by means of a laser beam, resulting in inferior regenerated-signals.

An optical disk in accordance with a first aspect of the present invention, which aims to overcome the above-discussed and numerous other disadvantages and deficiencies of the prior art, comprises guide grooves and pits on one surface thereof, wherein the depth of said guide grooves is different from that of said pits, and is characterised in that the distance from the bottom face of each of said guide grooves to the other surface of said optical disk opposite to said one surface of said optical disk on which said guide grooves and pits are disposed is the same as the distance from the bottom face of each of said pits to the other surface of said optical disk opposite to said one surface of said optical disk on which said guide grooves and pits are disposed.

A method for the production of optical memory master plates in accordance with a second aspect of the present invention comprises forming a photoresist film on a disk plate, exposing said photoresist film to beams, developing said photoresist film resulting in a patterned photoresist film, and forming a metal film on said disk plate with the patterned photoresist film, and is characterised in that, said exposure process, a plurality of beams that are disposed in the radius direction of said disk plat illuminate said photoresist film through an obj ct lens, then said plurality of beams are shift d radially

in such a way that an area that is exposed after said beams are shifted is superposed on a part of the area that has been exposed before said beams are shifted, and then said beams illuminate said photoresist film, resulting in an exposed area that is wider than the exposed area formed before said beams are shifted, said widely exposed area constituting a guide-groove latent image.

In a preferred embodiment, the disk plate is made of glass or plastics. The above-mentioned optical disk is produced by the use of the master plate.

A method for the production of optical memory master plates in accrodance with a third aspect of the present invention comprises forming a photoresist film on a disk plate, exposing said photoresist film to beams, developing said photoresist film resulting in a patterned photoresist film, and forming a metal film on said disk plate with the patterned photoresist film, and is characterised in that, in said exposure process, a first beam and a second beam illuminate said photoresist film with a fixed gap therebetween in the radius direction of said disk plate so as to form a first exposed area and a second exposed area, then these beams are shifted radially with said fixed gap therebetween in such a way that said first beam is superposed with a part of said second exposed area, then said first and second b ams illuminate said photoresist film, and then the above-mentioned steps are repeated, resulting in unexposed areas with a width that corresponds to said fixed gap and widely exposed areas that are composed of said first and second exposed areas.

In a preferred embodiment, the disk plate is made of glass or plastics. The above-mentioned optical disk is produced by the use of the master plate.

Thus, the invention described herein makes possible the objectives of (1) providing an optical disk for use in optical memory devices, in which the bottom face of each of the guide grooves is so flat and smooth that optical memory devices that produce high quality regenerated signals can be obtained; and (2) providing a method for producing the optical disk by which the guide grooves can be formed with accuracy by means of laser beams that are at a relatively low intensity level.

By way of example only, a specific embodiment of the present invention will now be described, with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view showing an enlarged portion of an embodiment of optical disk in accordance with the present invention for use in optical memory devices;

Figures 2a to 2d are schematic diagrams showing a production process of the optical disk of Figure 1;

Figure 3 is a diagram showing an optical system that is used in the process shown in Figures 2a to 2d;

Figure 4 is a schematic diagram showing an exposing process for the production of an optical memory master plate that is used for the production of an optical disk as shown in Fig. 1;

Figures 5a-5b and 6a-6b are schematic diagrams showing the steps for the formation of guide groove latent images on the photoresist film in the exposing process shown in Figure 4;

Figures 7a and 7b are schematic diagrams showing the steps for the formation of pit latent images on the photoresist film in the exposing process shown in Figure 4;

Figure 8 is a schematic diagram showing the disposition of pits and grooves on the photoresist film corresponding to the header of the master plate according to the method of this invention;

Figure 9 is the time charts of the modulating signals and the deflecting signals of laser beams by which the pit latent images and the guide groove latent images corresponding to the pits and the grooves of Figure 8 are formed on the photoresist film;

Figure 10 is a perspective view showing a conventional disk; and

Figures 11a to 11d are schematic diagrams showing a production process of the disk shown in Figure 10.

This invention provides an optical disk having pits and guide grooves in which the bottom face of each pit is flush or level with the bottom face of each guide groove.

Example 1

Figure 1 shows an optical disk of this invention, which is made of glass, plastics or the like. The optical disk 5 has guide grooves 1, which function as guide tracks, and pits 2 on one surface 51 thereof. Both the bottom face of each groove 1 and the bottom face of each pit 2 are positioned at the same distance from the other surface 52 of the optical disk 5; that is, the bottom face of each of the grooves 1 is flush or level with that of each of the pits 2. The depth D1 of each of the grooves 1 is different from the depth D2 of each of the pits 2. The value of D1 is set to be usually around $\lambda/8$ n and the value of D2 is set to be usually in the range of around $\lambda/8$ n to $\lambda/4$ n (wherein λ is a wavelength of light and n is the refractive index of the optical disk).

Figures 2a to 2d show a production process of the optical disk shown in Figure 1. On a disk plate 10 of glass or plastics, as shown in Figure 2a, a photoresist film 6 is formed, which is then illuminated with light 7 such as laser beams or the like via an optical lens 20 so as to form latent patterns corresponding to the desired shape of guide grooves 1 and pits 2 shown in Figure 1. Then, the photoresist film 6 with a latent pattern is developed, as shown in Figure 2b, resulting in a pattern 66 that corresponds to the guide grooves 1 and the pits 2 shown in Figure 1.

The production of such a pattern 66 is described in detail below: Figure 3 shows an optical system with a laser apparatus that is used in the above-mentioned process for the production of the pattern 66. The optical system comprises a laser apparatus 11, beam splitters 12 and 18, reflectors 13 and 19, optical modulators 14 and 15, a deflector 16, and an 1/2 wavelength plate 17. A laser beam that is emitted from the laser apparatus 11 is split into two laser beams 21 and 22 by the beam splitter 12. The laser beam 21 arrives at the beam splitter 18 through the

optical modulator 14 and the deflector 16. The other laser beam 22 is reflected by the reflector 13 and arrives at the reflector 19 through the optical modulator 15 and the 1/2 wavelength plate 17. The laser beam 22 is reflected by the reflector 19 and arrives at the beam splitter 18. The laser beams 21 and 22 meet in the beam splitter 18 and are incident together upon an object lens 20. The 1/2 wavelength plate 17 functions to change the wave surface of the laser beam 22, thereby preventing the laser beams 22 from interfering with the laser beam 21. Figure 4 shows the exposure of a photoresist film 6 to the laser beams 21 and 22 at the times of the production of an optical memory master plate. Figures 5a-5b and 6a-6b show the steps for the formation of guide groove latent images on the photoresist film in the exposing process shown in Figure 4. The laser beams 21 and 22 that are condensed into a spot fashion, respectively, by the object lens 20 illuminate the top surface of the photoresist film 6 in such a way that the laser beam spots are positioned at a fixed distance d therebetween in the radius direction of the disk plate 10 (Figures 5a and 5b). The unexposed area 23 that is positioned between the beams 21 and 22 constitutes an area corresponding to a land 4 of Figure 1 after it is developed. The exposed areas 24 and 25 that are exposed to the beams 21 and 22 constitute areas corresponding to guide grooves 1 of Figure 1 after they are developed. Then, the optical system is shifted in the radius direction of the disk plate 10 (i.e., in the direction of arrow A) so that the light spot of the laser beam 22 can be superposed on a part of the above-mentioned exposed area 24 by a distance L. Then, the disk plate 10 is rotated, so that as shown in Figures 6a and 6b, an exposed area 1 that is composed of the above-mentioned exposed area 24 and an newly exposed area 25a, both of which overlap by the area 250 with a width L, is formed and at the same time, an exposed area 24a is newly formed across an unexposed area 23a with a distance d from the said exposed area 1.

The above-mentioned steps are repeated, and the xposed areas 1 that are wider than the exposed area 24 or 25 are formed on the photoresist film 6. The width d of the unexposed areas 23 and 23a has no relation with the shifting pitch of the optical system and can be adjusted by changes in the gap between the laser beams 21 and 22, so that it can be maintained precisely.

Figures 7a and 7b show the step for the formation of pit latent images on the photoresist film corresponding to the header of the optical memory master plate. Figure 8 shows the disposition of pits and guide grooves on the photoresist film corresponding to the header of the master plate. Figure 9 shows time charts of modulating signals and deflecting signals of the laser beams 21 and 22 by which the exposed ar as of Figure 8 are formed.

The modulating signals S1 and S2 (Figure 9) of the laser beams 21 and 22, respectively, are output and the exposed areas 24 and 25 are formed on the photoresist film 6. At a time of t1, the modulating signals S1 and S2 of the laser beams 21 and 22 are off and the deflecting signal S3 of the laser b am 21 is on (Figure 9), so that as shown in Figure 7a, the laser beam 21 is deflected toward the position 21a and the incidence of the laser beams 21 and 22 upon the object lens 20 is cut off. Then, during the periods T1, T2 and T3 of time, the modulating signal S1 of th laser beam 21 is output (Figure 9) and the laser beam 21a illuminates the photoresist film 6, resulting in exposed areas 24a with a narrow width on the header of the master plate. The output power of the laser beam 21a is slightly lowered, which makes the spot diameter small, and at the same time, the spread of the laser beam 21a is deflected by the deflector 16 that receives the deflecting signal S3 in such a way that the spot of the laser beam 21a is positioned at a line extending from the center of the above-mentioned exposed area 1 (Figure 7b), and accordingly the laser beam 21a is incident upon the object lens 20. Then, at a time of t2, the deflecting signal S3 of the laser beam 21 is off and the modulating signals S1 and S2 of the laser beams 21 and 22, respectively, are on, so that the laser beams 21 and 22 are again incident upon the object lens 20, resulting in exposed areas 24 and 25 on the photoresist film 6. The width d of each of the above-mentioned unexposed areas can be precisely adjusted by the deflection of the laser beam 21 by means of the deflector 16 or by the rotation of the reflector 19 by means of a reflector-rotating means (not shown).

The heights of the unexposed areas 23 and 23a of a pattern 66 that is obtained by the development of the photoresist film 6 depend upon the intensity of the laser beams 21 and 22, and the time length of the development or the like. The depth and width of the pits can be set at a desired value by controlling the intensity of the laser beam 21a (Figures 7a and 7b) at the times of the formation of pits. In this way, the desired pattern 66 corresponding to the guide grooves 1 and the pits 2 of the optical disk 5 of Figure 1 is formed on the resist film 6.

Then, on the disk plate 10 with the pattern 6 (Figure 2b), as shown in Figure 2c, a metal film 8 made of nickel (Ni) or the like is formed by the sputtering method, the vacuum evaporation method, the electro forming method, or the like, resulting in a stamper (i.e., a master plate) 88 shown in Figure 2d. By the use of the stamper 88, an optical disk 5 such as that shown in Figure 1 can be produced by an injection technique, a casting technique or the like. The bottom faces of the grooves 1 and the pits 2 of this optical disk 5 are very flat and smooth because they transcribe the surface of the glass or plastic disk plate 10 that is very flat and smooth.

Claims

1. An optical disk (5) for use in optical memory devices comprising guide grooves (1) and pits (2) on one surface (51) thereof, wherein the depth (D1) of said guide grooves (1) is different from that (D2) of said pits (2), characterised in that the distance from th

bottom face of each of said guide grooves (1) to the other surface (52) of said optical disk (5) opposite to said one surface (51) of said optical disk on which said guide grooves (1) and pits (2) are disposed is the same as the distance from the bottom face of each of said pits (2) to the other surface (52) of said optical disk opposite to said one surface (51) of said optical disk on which said guide grooves (1) and pits (2) are disposed.

2. A method for the production of optical memory master plates (88) comprising forming a photoresist film (6) on a disk plate (10), exposing said photoresist film to beams (21,22), developing said photoresist film resulting in a patterned photoresist film (66), and forming a metal film (8) on said disk plate with the patterned photoresist film, characterised in that, in said exposure process, a plurality of beams (21,23) that are disposed in the radius direction of said disk plate (10) illuminate said photoresist film (6) through an object lens (20), then said plurality of beams are shifted raidally in such a way that an area (25a) that is exposed after said beams shifted on a part (25o) of the area (24) that has been exposed before said beams are shifted, and then said beams illuminate said photoresist film (6), resulting in an exposed area (1) that is wider than the exposed area (24) formed before said beams are shifted, said widely exposed area constituting a guide-groove latent image.

3. A method according to claim 2, wherein said disk plate (10) is made of glass or plastics.

4. A method according to claim 3, wherein the optical disk (5) of claim 1 is produced by the use of the master plate (10) of claim 2.

5. A method for the production of optical memory master plates (88), comprising forming a photoresist film (6) on a disk plate (10), exposing said photoresist film (6) to beams (21,22), developing said photoresist film (6) resulting in a patterned photoresist film (66), and forming a metal film (8) on said disk plate (10) with the patterned photoresist film (66), characterised in that, in said exposure process, a first beam (22) and a secomd beam (21) illuminate said photoresist film (6) with a fixed gap (d) therebetween in the radius direction (A) of said disk plate so as to form a first exposed area (25) and a second exposed area (24), then these beams (22,21) are shifted radially with said fixed gap (d) therebetween in such a way that said first beam (22) is superposed with a part (25o) of said second exposed area (24), then said first and second beams (22, 21) illuminate said photoresist film (6), and then the above-mentioned steps are repeated, resulting in unexposed areas (23) with a width (d) that corresponds to said fixed gap and widely exposed areas (1) that are composed of said first (24) and second exposed (25o) areas.

6. A method according to claim 5, wherein said disk plate (10) is made of glass or plastics.

7. A method according to claim 6, wherein the optical disk (5) of claim 1 is produced by the use of the master plate (81) of claim 6.

Fig. 1

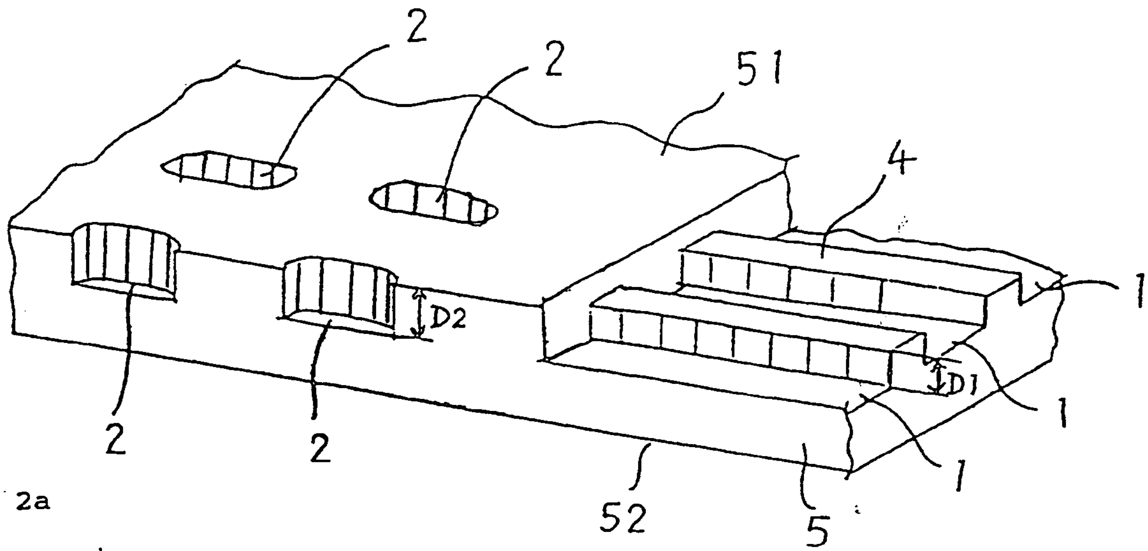


Fig. 2a

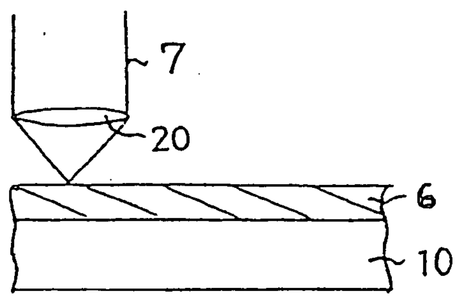


Fig. 2d

Fig. 2b

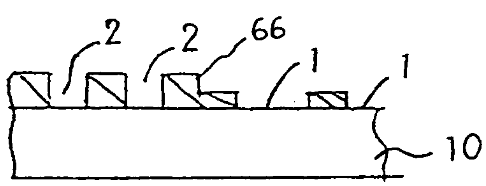


Fig. 2c

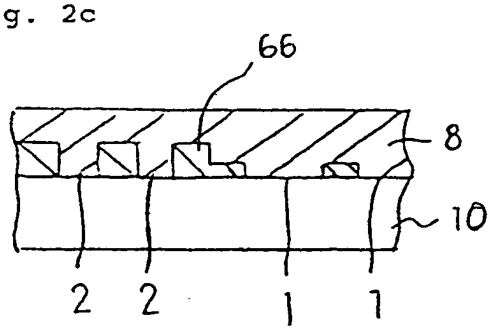


Fig. 3

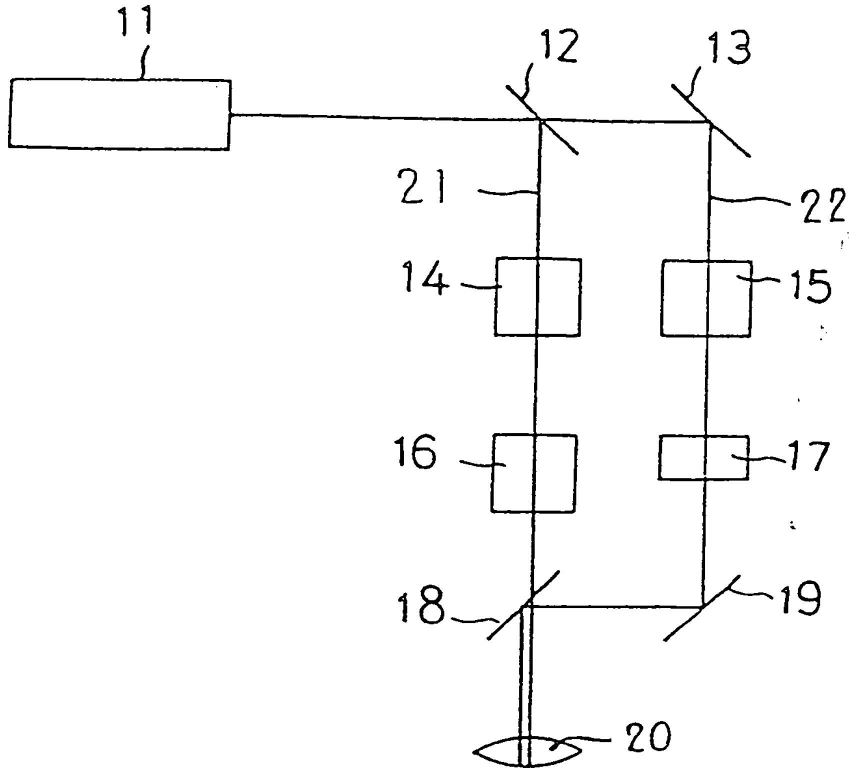


Fig. 4

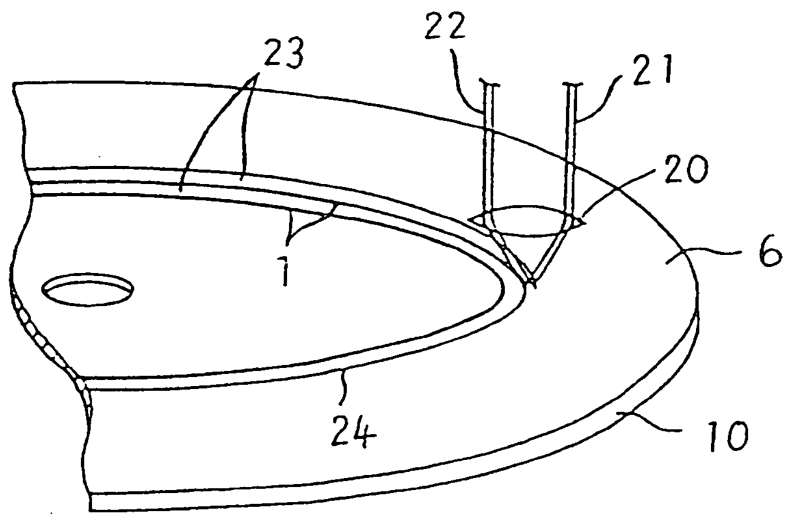


Fig. 5a

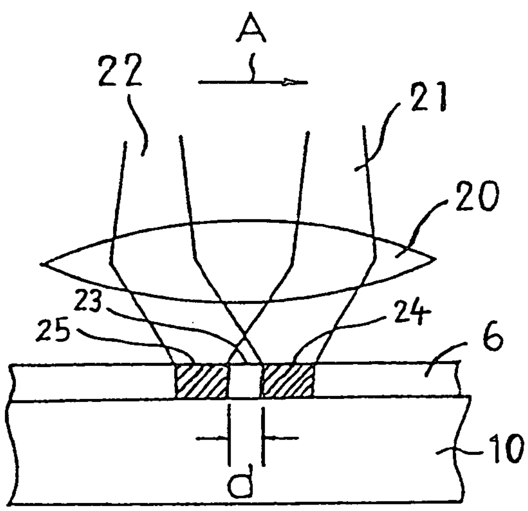


Fig. 6a

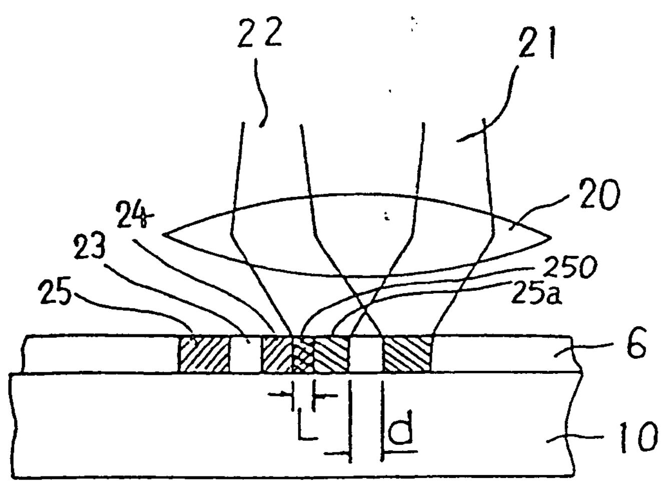


Fig. 5b

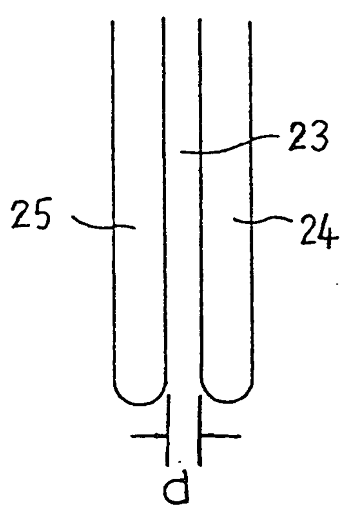


Fig. 6b

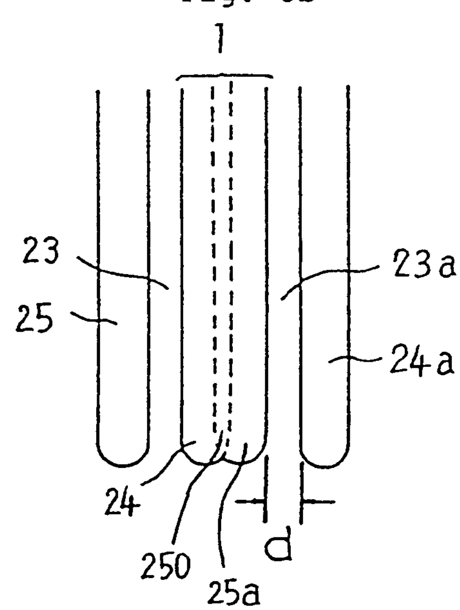


Fig. 7a

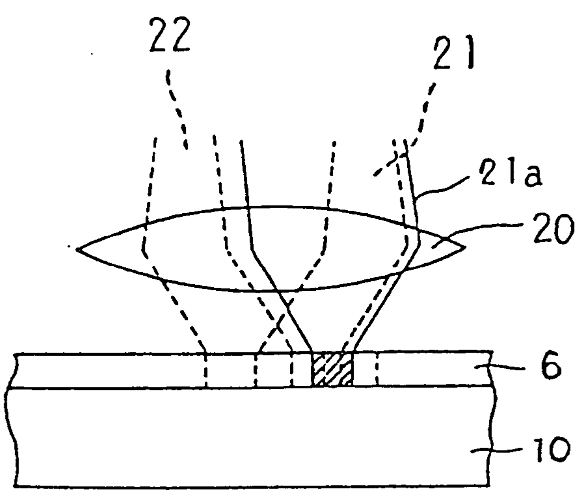


Fig. 7b

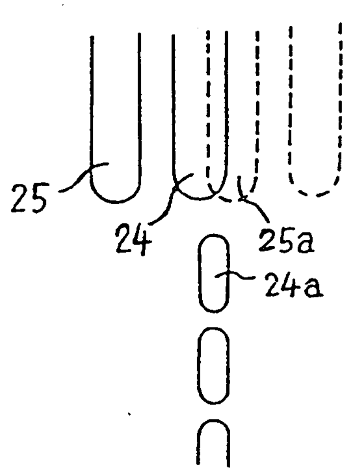


Fig. 8

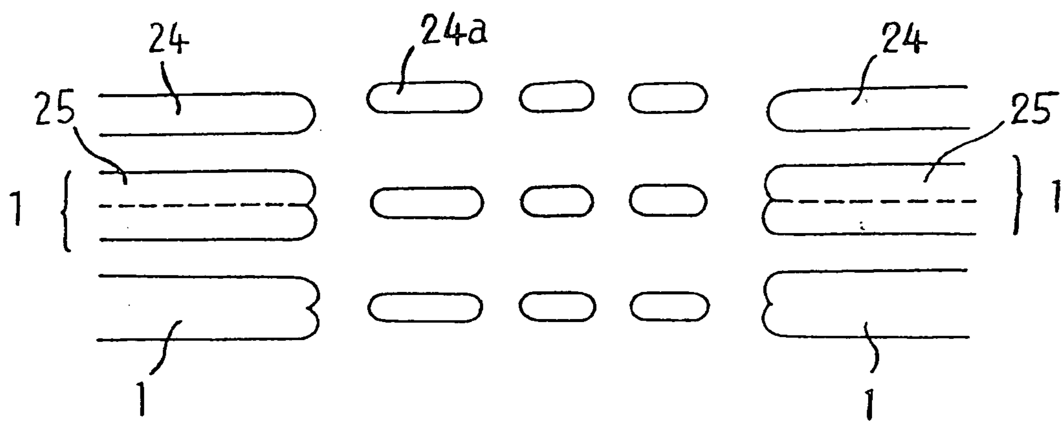


Fig. 9

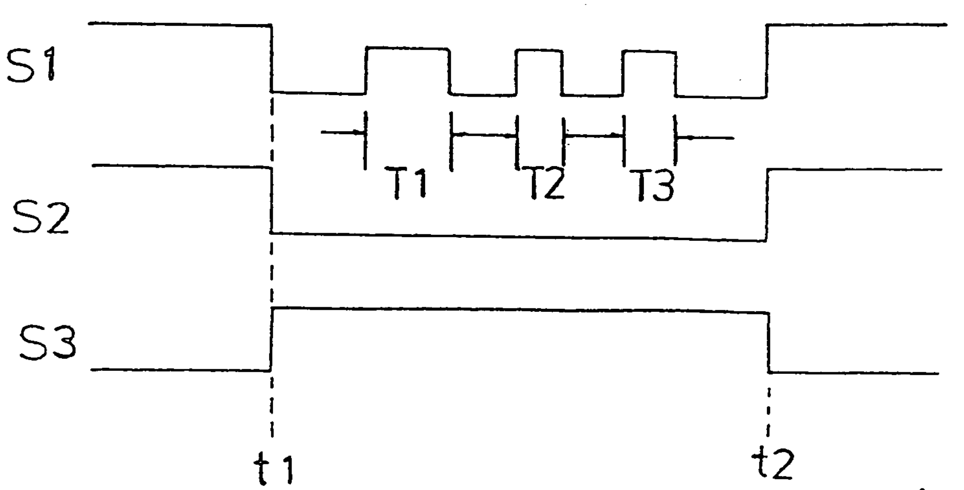


Fig. 10

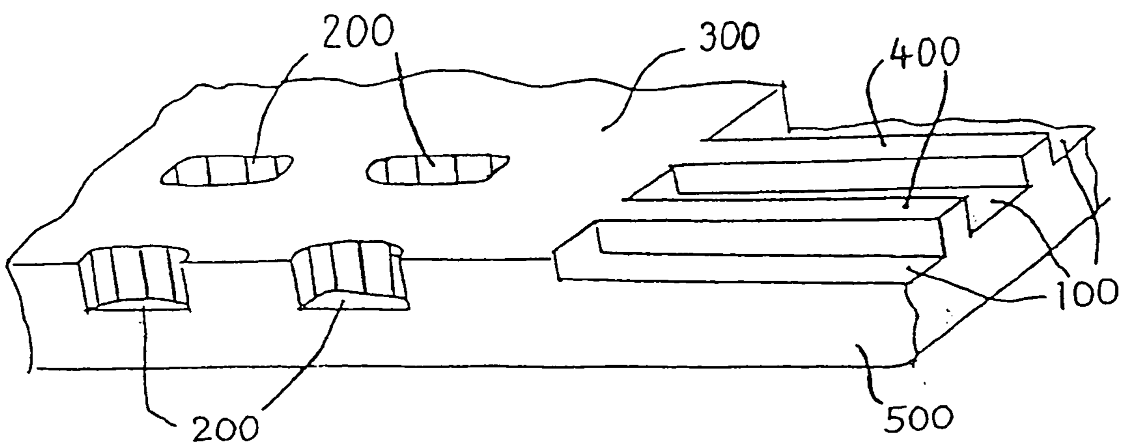


Fig. 11a

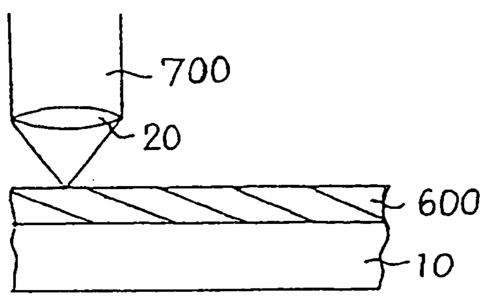


Fig. 11b

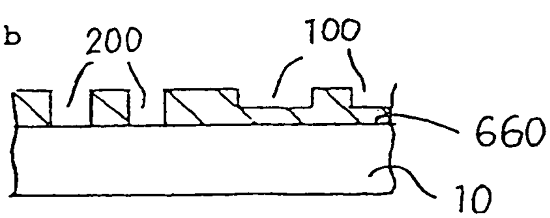


Fig. 11c

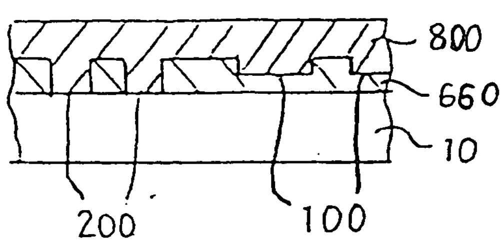
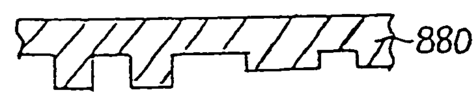


Fig. 11d



European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 88307691.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE - A1 - 3 620 331 (OLYMPUS OPTICAL CO. LTD.) * Fig. 1,9; claims 1,2 * ----	1	G 11 B 7/007 G 11 B 7/013

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

G 11 B 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-11-1988	BERGER

CATEGORY OF CITED DOCUMENTS

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